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TRANSMISSION COEFFICIENT MEASUREMENTS OF UV  
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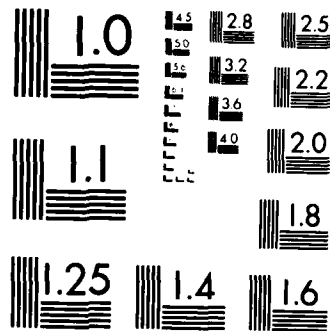
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# TRANSMISSION COEFFICIENT MEASUREMENTS OF UV WINDOW/FILTER/LENS SYSTEM FOR VINTON CAMERA

by

S.M. Khanna

and

R.G. Apps

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# **TRANSMISSION COEFFICIENT MEASUREMENTS OF UV WINDOW/FILTER/LENS SYSTEM FOR VINTON CAMERA**

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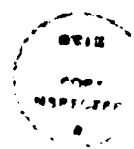
**September 1983  
Ottawa**

### ABSTRACT

The UV transmission coefficients of various optical components of the CF Vinton camera system were measured in the laboratory over 320-950 nm wavelength region. The suitability of these components for use in UV aerial surveillance work was assessed.

### RÉSUMÉ

On a mesuré en laboratoire et à des longueurs d'ondes variant de 320 à 950 nm le coefficient de transmission des rayons UV des différents dispositifs optiques du système d'appareil photographique Vinton des FC. Par la même occasion, on a procédé à l'évaluation de ces dispositifs pour les activités de surveillance aérienne au moyen de rayons UV.



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## 1. INTRODUCTION

The present work on UV transmittance measurements of the optical components of the Canadian Forces Vinton camera system was conducted under tasking from CF Photographic Unit in support of their evaluation/modification of this system for eventual use in UV aerial surveillance.

## 2. Experimental Procedure

The transmittance characteristics of the following optical components of the Vinton camera system were measured in the laboratory over 320-950 nm wavelength region.

1. UV filter.
2. Window.
3. UV lens no. C383.
4. Window and lens combination with the window facing the incident radiation.
5. UV filter and lens combination with the filter facing the incident radiation.
6. Window, filter and lens combination with the window facing the incident radiation.

A Beckman Model DU spectro-radiometer was modified to serve as a monochromator. A parallel beam of varying size was obtained through a pair of lenses and stops in conjunction with the monochromator. A photomultiplier tube was used as the detector. The object under study was placed close to the photomultiplier tube and the radiant flux was measured (1) with and (2) without the object in the path of the beam. The ratio of the two measurements gives the transmittance of the object at that wavelength. All measurements were taken with normal incidence and a spot size of  $\sim 1.2$  cm dia. These measurements were calibrated by determining the transmittance of a standard holmium oxide filter by this method. These measurements indicate an accuracy of  $\pm 1\%$  in transmission coefficient measurements in the present work.

## 3. RESULTS AND DISCUSSION

Figs. 1-6 show the transmission coefficient vs. wavelength plots for the various optical components over 320-950 nm wavelength region. These results are also given in Table 1 for ready reference. In the following, we discuss these results briefly and note their salient features.

### UV FILTER (FIG. 1)

This should be a good filter for UV aerial surveillance over 320-390 nm wavelength region. Two notable features of this filter are its high transmittance over most of these wavelengths and almost no transmittance at wavelengths  $\geq 390$  nm.



#### WINDOW (FIG. 2)

The window has a relatively poor transmission in almost half of the UV region of interest ( $\sim 320\text{--}380\text{ nm}$ ) although it has a good transmission coefficient ( $> 70\%$ ) over wavelengths above  $350\text{ nm}$ . The transmission is rather flat above  $400\text{ nm}$ . The sharp decrease in transmission of the window below  $350\text{ nm}$  is an undesirable feature for UV aerial surveillance.

#### LENS (FIG. 3)

The lens suffers from similar poor transmission properties as the window over most of the wavelength region of interest for UV aerial surveillance. In fact, the transmittance of the lens is much lower than that of the window over  $320\text{--}350\text{ nm}$  region.

Thus, both the lens and window suffer from the same problem. In both cases, the transmission is high at wavelengths  $> 375\text{ nm}$ . Further, the lens has much lower transmission than the window in the UV wavelength region. In a way, it may be argued that the transmission characteristics of the window and lens are not matched to the high transmission of the filter.

#### WINDOW/LENS COMBINATION (FIG. 4)

As the transmission for the window is almost flat for wavelengths higher than  $400\text{ nm}$ , the transmission for this combination is quite similar to that of the lens. However, in the UV region of interest and specially below  $350\text{ nm}$ , the lens/window combination has substantially lower transmission than that of the lens alone due to decreasing transmission of the window with decrease in wavelength over this region.

#### FILTER/LENS/COMBINATION (FIG. 5)

This is a good filter/lens combination for UV aerial photography. It has a peak transmittance of  $32\%$  at  $360\text{ nm}$  and the half power bandwidth of the passband is  $35\text{ nm}$ . Further, it is totally blocked at wavelengths longer than  $390\text{ nm}$ .

#### WINDOW/FILTER/LENS COMBINATION (FIG. 6)

This may be the most relevant case for UV aerial surveillance. This system has a peak transmission of  $\sim 25\%$  at  $361\text{ nm}$  and half power bandwidth of  $30\text{ nm}$ . Further, there is practically no leakage of radiation at wavelengths higher than  $390\text{ nm}$ .

#### 4. CONCLUSIONS

In summary, the present system consisting of the window, UV filter and UV lens form a reasonably good system for use in UV aerial surveillance. In particular, the system is totally blocked above  $\sim 390\text{ nm}$ . However, it has a relatively limited peak transmission and the passband does not extend to still shorter UV wavelengths which are transmitted through the atmosphere.

The transmittance of the system could be increased and extended to shorter UV wavelengths by improving the UV transmission characteristics of the (1) lens or/and (2) window.

As discussed above, the filter/lens combination has higher transmittance than the window/filter/lens combination and should be used whenever it is feasible.

Table 1 Transmittance of the optical components of CF Vinton camera system at different wavelengths.

Wavelength	Window	UV Filter for C383 Lens	C383 UV Lens	Window plus C383 UV Lens	UV Filter plus C383 UV Lens	UV Filter plus Window plus C383 UV Lens
(nm)	(%)	(%)	(%)	(%)	(%)	(%)
950	95.0	0.0	76.9	73.2	0.0	0.0
900	95.0	0.0	78.9	74.1	0.0	0.0
850	96.2	0.0	80.5	76.3	0.0	0.0
800	96.3	0.0	88.6	82.3	0.0	0.0
750	96.8	0.0	96.0	88.9	0.0	0.0
700	96.8	0.0	83.5	78.1	0.0	0.0
650	96.4	0.0	76.7	72.8	0.0	0.0
600	96.3	0.0	75.4	72.3	0.0	0.0
550	96.0	0.0	77.2	73.9	0.0	0.0
500	94.9	0.0	81.2	76.8	0.0	0.0
450	92.7	0.0	83.6	77.8	0.0	0.0
400	90.2	0.0	81.6	73.6	0.0	0.0
395	89.4	0.0	80.2	71.6	0.0	0.0
390	87.8	0.0	78.6	68.9	0.0	0.0
385	86.2	0.6	76.5	65.7	0.6	0.5
380	84.9	6.2	73.7	62.7	4.2	4.0
375	84.8	19.3	70.3	59.7	12.6	11.5
370	84.0	35.0	66.1	55.7	24.3	19.4
365	82.3	48.8	60.3	49.8	29.5	24.5
360	79.6	59.0	54.3	43.0	32.1	25.5
355	75.7	65.7	46.0	35.0	30.1	23.2
350	69.5	70.9	37.8	26.3	26.5	18.6
345	61.8	74.3	28.7	19.3	21.0	13.1
340	52.0	76.4	20.0	10.4	16.7	7.6
335	40.1	77.4	12.5	5.3	9.6	3.5
330	27.8	78.7	6.3	2.4	4.3	0.5
325	16.6		3.6	0.0	2.3	0.0
320	-		0.0	0.0	0.0	0.0

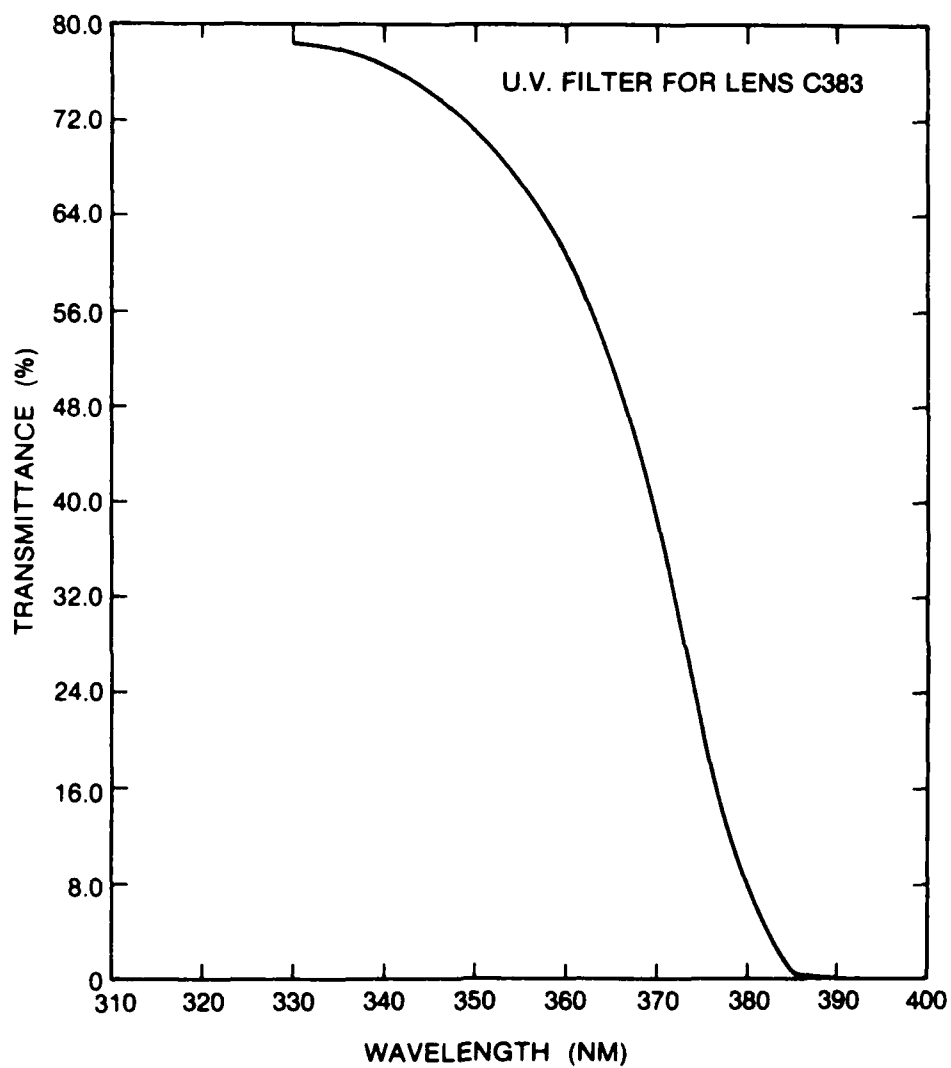


Fig. 1 Transmittance characteristics of the UV filter for the lens no. C383.

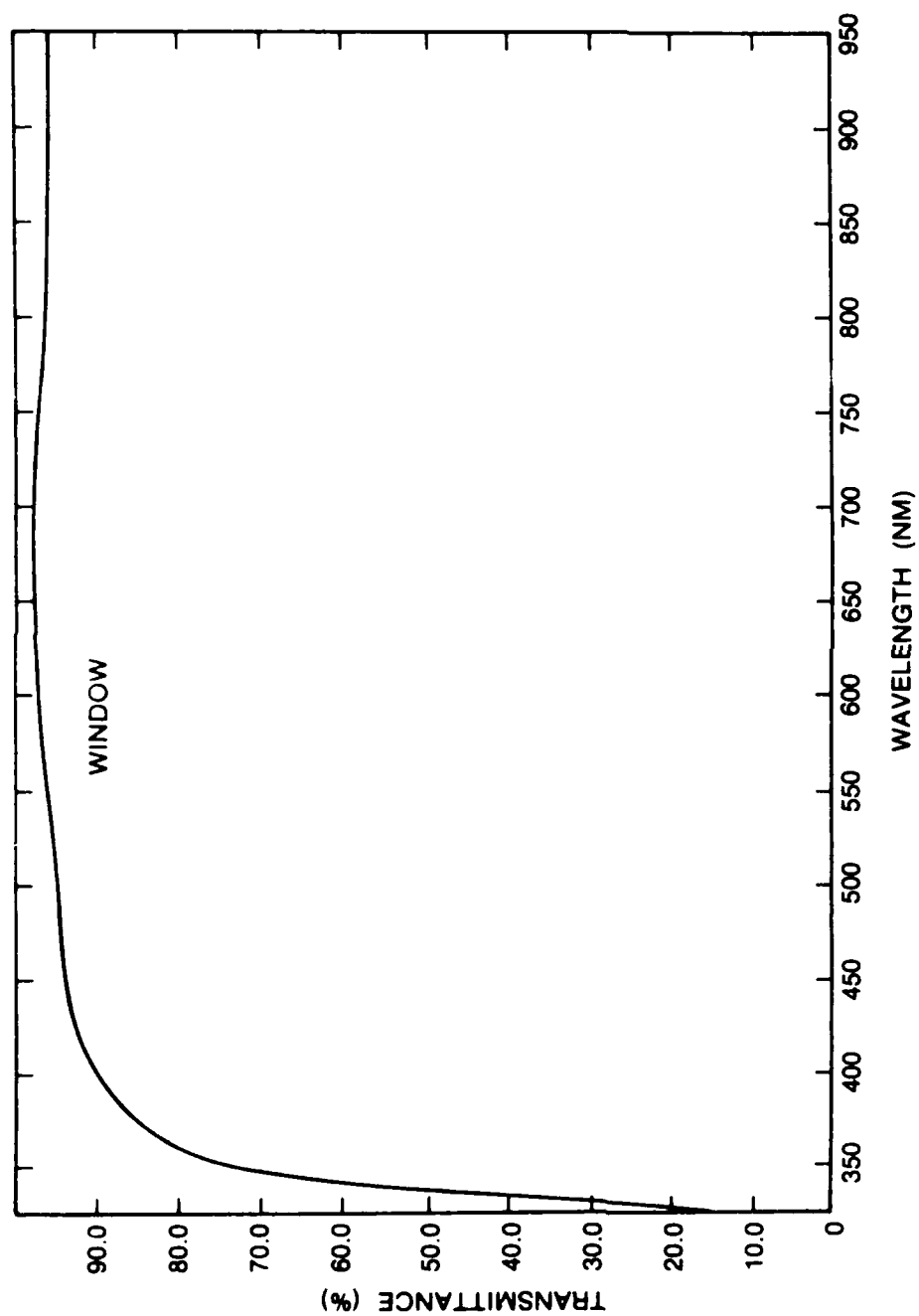


Fig. 2 Transmittance characteristics of the window over 320-950 nm region.

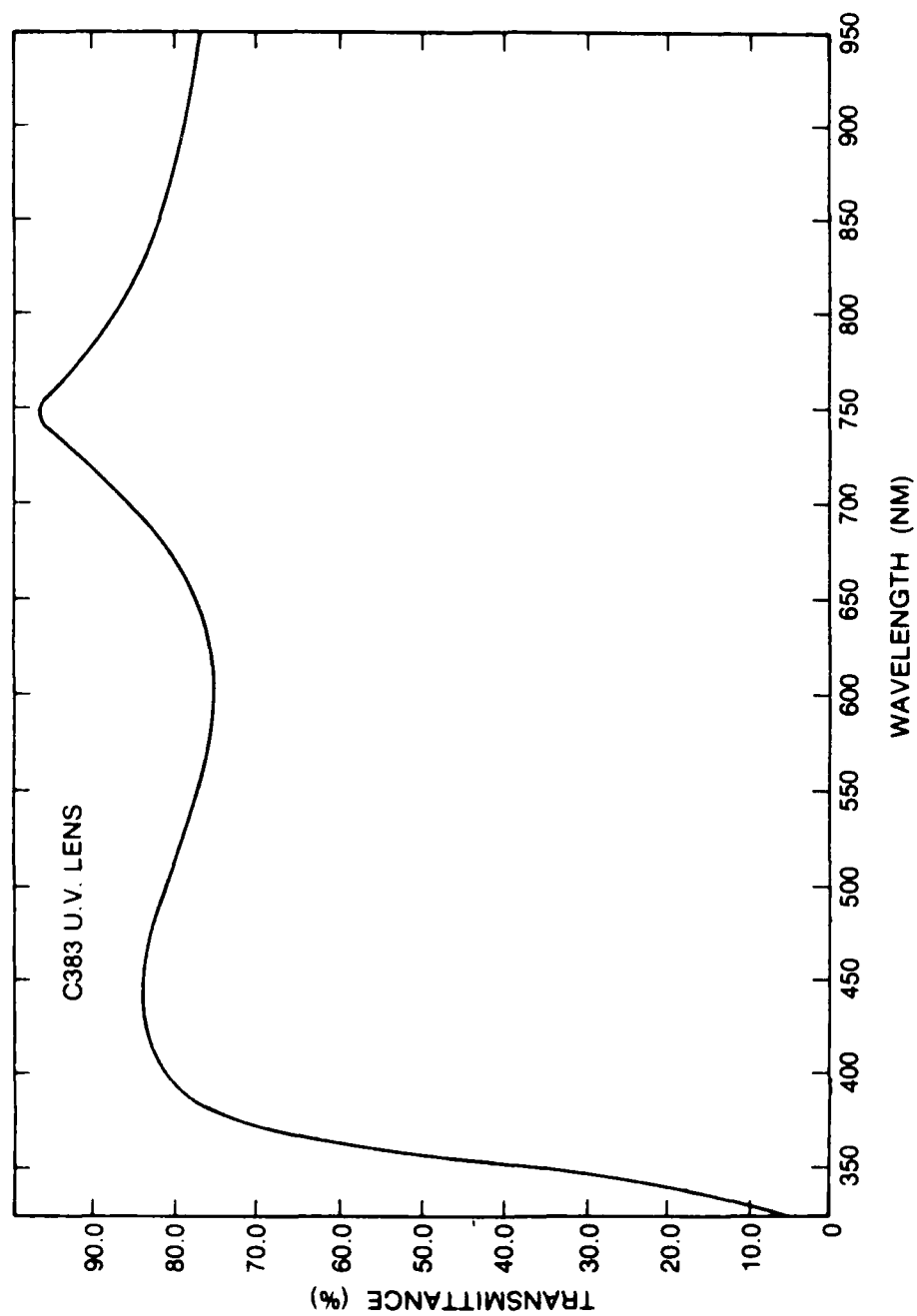


Fig. 3 Transmittance characteristics of the UV lens no. C383

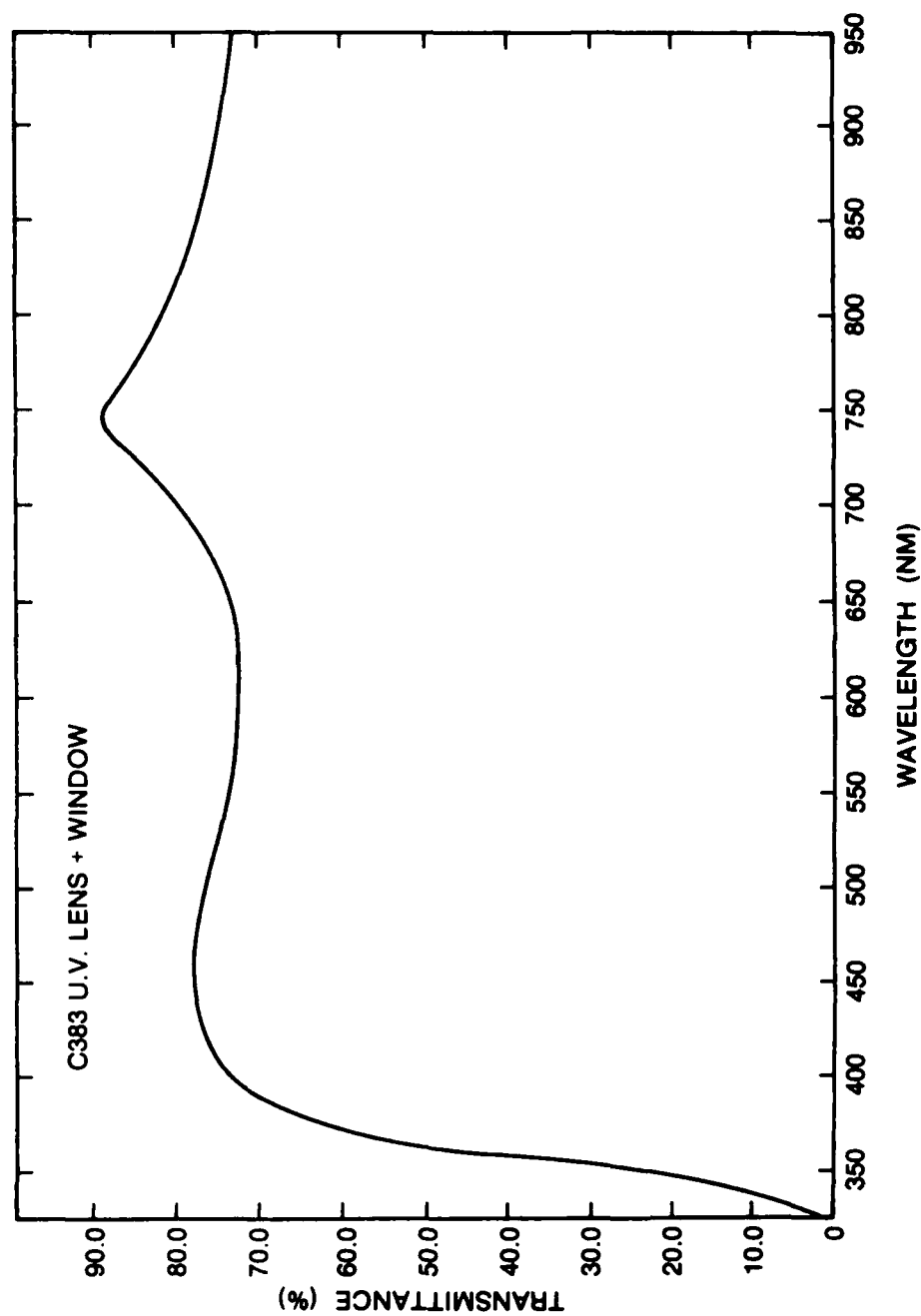


Fig. 4 Transmittance characteristics of the window/UV lens no. C383 combination over 320-950 nm region.

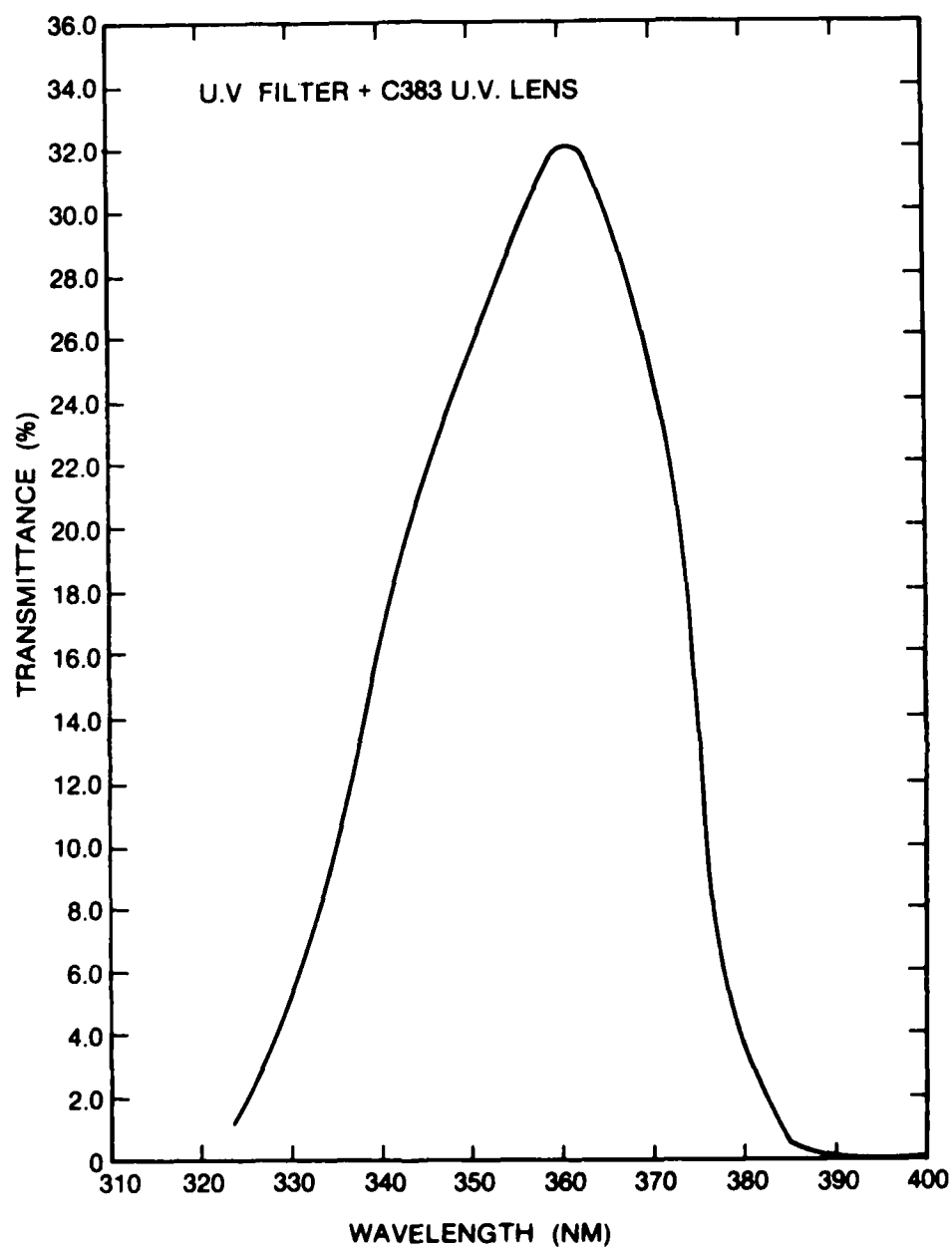


Fig. 5 Transmittance characteristics of the UV filter/UV lens no. C383 combination.



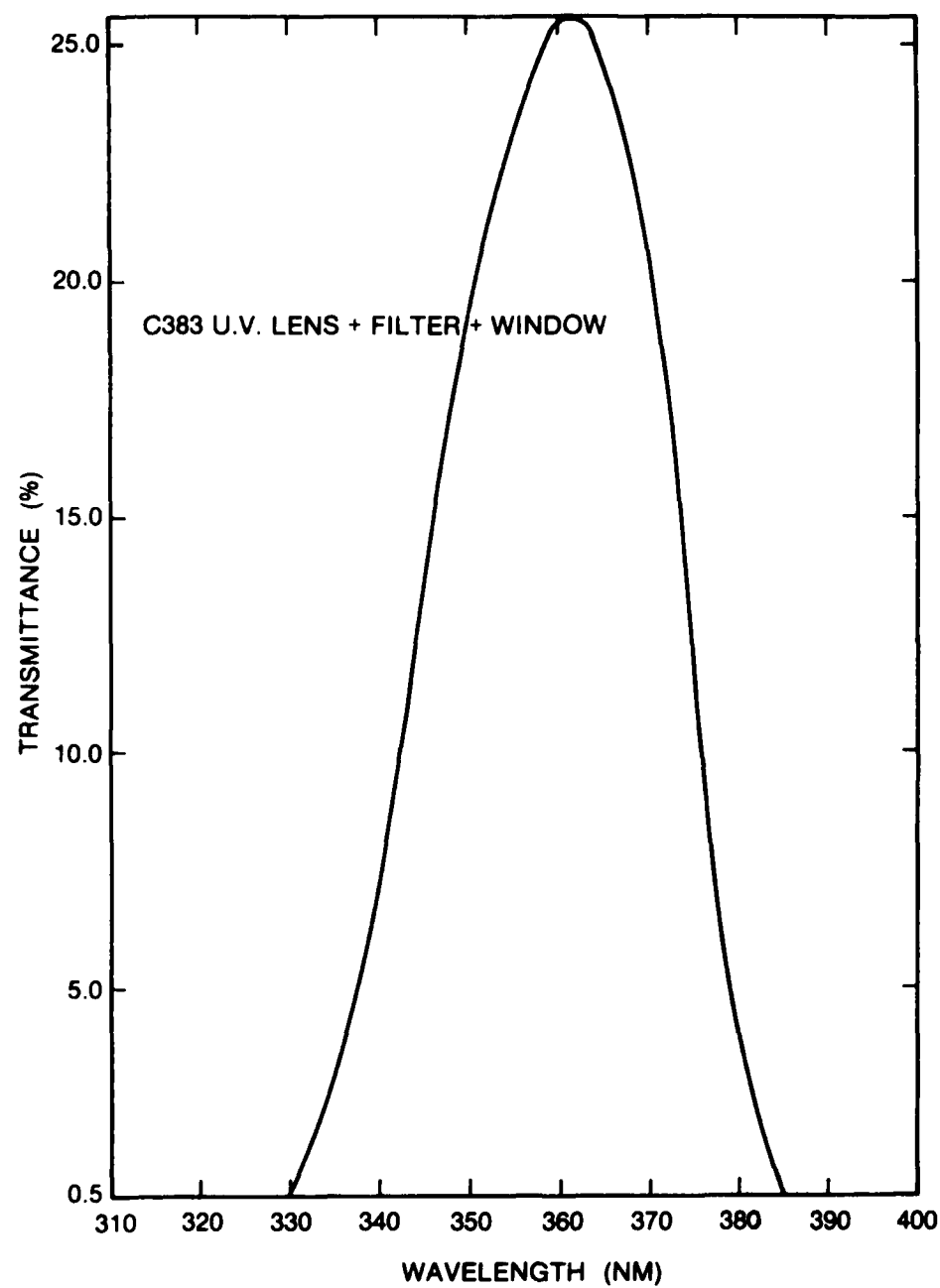


Fig. 6 Transmittance characteristics of the window/UV filter/UV lens no. C383 combination.

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